S. M. JHA*, Amita SINGH* & A. K. PANDEY*: **Development of female gametophyte, endosperm and embryo in *Tagetes minuta* L. (Asteraceae)**

S. M. ジャ*・A. シン*・A. K. パンデイ*: シオザキソウ（キク科）の胚学的研究

Embryological studies in *Tagetes* (Heliantheae, Asteraceae) have been carried out in *T. sigmatus* (Dahlgren 1920) and *T. patula* (Venkateswarlu & Maheswari Devi 1955). Developmental anatomy of seeds and fruits in *Tagetes* have been studied in *T. erecta* and *T. patula* (Pandey *et al.* 1986). A perusal of literature reveals that embryological studies in *T. minuta* have not been done. The present paper, therefore, deals with development of female gametophyte, endosperm and embryo in this taxon, a wild annual in hilly regions of India.

Materials and methods The materials for the present study were collected from Shillong (Pandey 5433). Capitula were fixed in formalin-acetic-alcohol and stored in 70% ethanol. Customary methods of dehydration in tertiary butyl alcohol series and embedding in paraffin wax were followed. Serial microtome sections cut between 7-12 μm thickness were stained in Haidenhain's Iron-alum, haematoxyline.

Observations Ovary and ovule. The syncarpous and unilocular ovary contains a single anatropous, unitegmic and tenuinucellate ovule (Fig. 1). The vascular supply of the ovule enters through funicle, overarches the chalaza and ends on the antiraphe side of the integument. The cells of the innermost layer of the integument elongate radially and differentiate into endothelium (Fig. 1, 7).

Megasporogenesis and female gametophyte. The female archesporium is hypodermal and single celled. It directly functions as megaspore mother cell (Fig. 2) and undergoes meiotic division resulting in the formation of a linear tetrad of megaspores. Usually three micropylar megaspores degenerate and the chalazal megaspore becomes functional (Fig. 3). In some cases both micropylar and chalazal megaspores show enlargement (Fig. 4). The chalazal me-

* Department of Botany, Bhagalpur University, Bhagalpur-812007 Bihar, India.

gaspore undergoes three mitotic divisions and produce an 8-nucleate embryosac of the *Polygonum* type (Figs. 5, 6, 7). The two polar nuclei fuse near the egg apparatus to from the secondary nucleus. The antipodal cells are three in number (Fig. 7) and persist till globular embryo stage.

Fertilization, endosperm and embryo. The fertilization is porogamous (Fig. 8). The pollen tube after its entry in the embryosac discharges its contents in the vicinity of the secondary nucleus. Syngamy and triple fusion occur simultaneously.

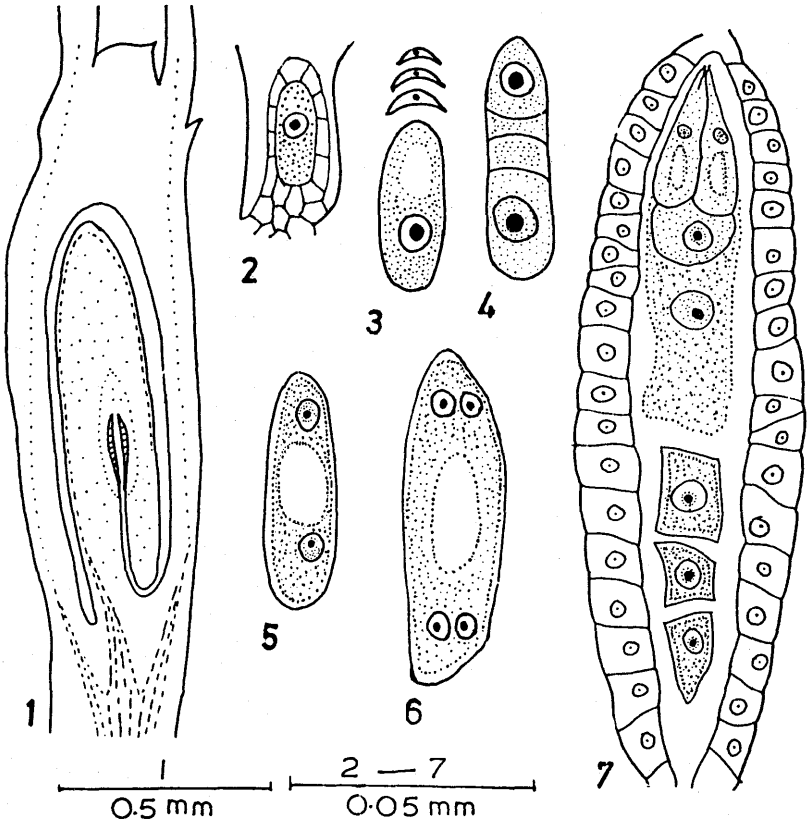
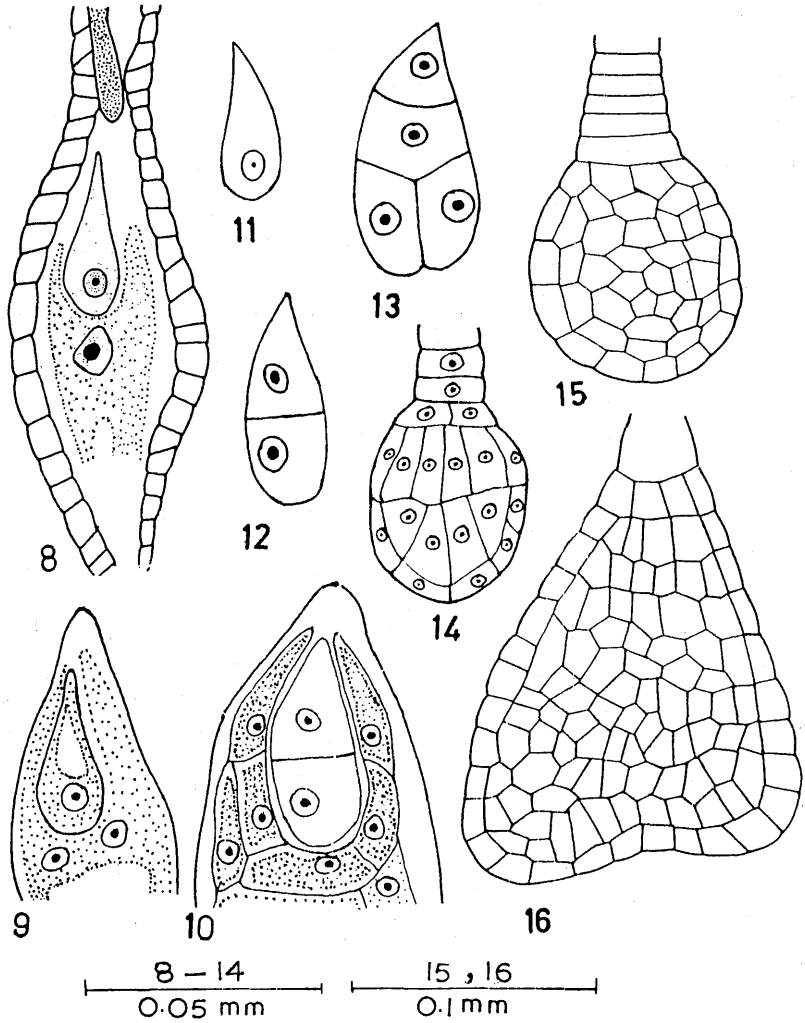


Fig. 1-7. *Tagetes minuta*. 1. Longitudinal section of ovary and ovule at organised female gametophyte stage. 2. Megaspore mother cell. 3. Megaspore tetrad. Note degenerating micropylar megaspores. 4. Megaspore tetrad. Note enlargement of micropylar and chalazal megaspores. 5, 6. 2-nucleate and 4-nucleate embryosacs respectively. 7. Organised female gametophyte.



Figs. 8-16. *Tagetes minuta* 8. Embryosac showing zygote and primary endosperm nucleus. 9, 10. Embryosac showing early stage of embryogeny and endosperm development. 11-16. Successive stages in the development of embryo.

The primary endosperm nucleus undergoes division not followed by wall formation (Fig. 9). Thus the development of the endosperm is Nuclear type. Free nuclear division results in the formation a number of nuclei. Wall formation begins from the micropylar side and proceeds towards the chalazal end (Fig. 10). By the time embryo reaches globular stage, the embryosac is filled with cellular endosperm. Digestion of the endosperm begins after this stage and in mature seed only a single layer of endosperm persists.

The first division of the zygote is transverse resulting in two celled proembryo, the terminal cell being *ca* and the basal *cb* (Figs. 11, 12). The cell *ca* divides vertically and the basal cell *cb* divides transversely to form a 4-celled proembryo (Fig. 13). The embryonal tetrad consists of juxtaposed cells derived from terminal cell and *m* and *ci* from the basal cell. The derivatives of the tier *ca* undergo one more vertical division and later oblique division resulting in octant. The cell *m* also undergoes two more vertical divisions at right angle to one another. The cell *ci* divides transversely resulting in the formation of *n* and *n'*, which later gives rise to cells *o* and *p* by transverse division. The derivatives of the tier *q* gives rise to the cotyledons and stem tip, *m* to the remaining part of the root tip and *p* to the suspensor of 2 to 6 cells (Figs. 14, 15, 16). Thus embryogeny conforms to the *Senecio* variation of Asterad type.

Discussion The development of female gametophyte in *Tagetes minuta* is *Polygonum* type, a feature also reported in majority of Asteraceae (Pullaiah 1984). The development of the endosperm is Nuclear type in *T. minuta*. Similar pattern of endosperm development has also been observed in *T. patula* (Venkateswarlu & Maheswari Devi 1955). On the other hand, in *T. signatus* (Dahlgren 1920), Cellular type of endosperm development has been reported. Both Cellular and Nuclear types of endosperm development have been reported in Asteraceae (Pullaiah 1984). The embryogeny follows *Senecio* variation of Asterad type, a characteristic pattern of embryogeny common to all Asteraceae.

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キク科センジュギク属のシオザキソウの胚学的研究を報告する。胚嚢形成は *Polygonum* type, 胚乳形成は Nuclear type, 胚形成は Asterad type の *Senecio* variation である。いずれもキク科の胚形成初期に見られる一般的な様式である。

○高等植物分布資料 (131) Materials for the distribution of vascular plants in Japan (131)

○シロバナミミカキグサ *Utricularia uliginosa* Vahl form. *albida* (Makino) Komiya 関東（千葉県成東町），中部（新潟県村松町，八ヶ岳），九州（宮崎県川南町）からの古い採集標本を見ることができるが，東北以北での分布は知られていなかった。ところが，1986年9月6日外山雅寛氏が北海道苫小牧市柏原東湿原において発見（NDC-3577, 3578），そして1988年9月18日筆者が福島県西白河郡西郷村段戸原にて採集(NDC-4039）したことで，シロバナミミカキグサが東北・北海道にまで分布することが明らかとなった。

シロバナミミカキグサの母種ムラサキミミカキグサは，本州では青森県に至るまでの全域各所に点在しており，北海道でも釧路湿原（鶴居村），石狩平野（浦臼町，月形町，新篠津村，江別市），勇払原野（苫小牧市），静狩湿原（長万部町）に現存することが最近再確認された。とくに，勇払の柏原東湿原と弁天沼及び静狩湿原では本州の自生地に見られぬ程の大群生を観察することができる。本州の自生地では6月から12月にかけて開花するのに対して，北海道では8月から10月初めにかけてと開花期は遅くて短かい。従って，花茎の高さは 1.5-6 (-8) cm と低く，花数も 1-2（稀に3）花と少い（本州産では 5-18 cm 高で2～7花)。元来ミミカキグサ類は熱帯乃至亜熱帯に分布する小形の多年生植物であるが，北海道では1年生植物として生活しているようである。

〔注〕 NDC: 日本歯科大学生物学教室標本庫。

（日本歯科大学 生物学教室 小宮定志 Sadashi KOMIYA)